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ABSTRACT

Although there continues to be controversy about the magnitude of genetic and environmental effects on human behavior, it is generally agreed by various scientific fields that individual differences in brain function and behavior must follow the same laws of variability as other human characteristics. Whether or not racial and ethnic group differences in behavior result in part from genetic differences is a matter of less consensus and little direct evidence. The continuing controversy about the role of genetic differences in behavior is fueled by two common misunderstandings: (1) sources of differences among people are confused with the causes of development, (2) the relative standing of an individual in comparison to his peers is confused with his actual level of performance. Thus, the malleability of behavioral development under more and less favorable environments is often underestimated when genetic differences are found to affect the rank order of individuals, as in a correlation coefficient. This paper examines several recent studies of biological families, adoptive families, and twins of various ages. There are three general conclusions: (1) that IQ levels and cognitive skills are malleable, (2) that the relative standing of a person in his intellectual peer group depends more on genetic than environmental differences, and (3) that the major source of differences in intellectual performance between blacks and whites is not genetic differences. The results are discussed in light of contemporary population biology, developmental theory and behavior genetic studies. (Author/AM)

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Genetic Effects on Human Behavior: Recent Family Studies

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ABSTRACT

Master Lecture on
Genetic Effects on Human Behavior: Recent Family Studies
by Sandra Scarr

Although there is continuing controversy about the magnitude of genetic and environmental effects on human behavior, there is a general consensus in the behavioral and social sciences that individual differences in brain function and behavior must follow the same laws of variability as other human characteristics. Whether or not racial and ethnic group differences in behavior result in part from genetic differences is a matter of less consensus and little direct evidence.

The continuing controversy about the role of genetic differences in behavior is fueled by two common misunderstandings. First, sources of differences among people are confused with the causes of development. For differences, either genetic or environmental differences in a population could be solely responsible for the observed human variation; for development to occur at all, both genes and environments are required. Second, the relative standing of an individual in comparison to his peers is confused with his actual level of performance. Thus, the malleability of behavioral development under more and less favorable environments is often underestimated when genetic differences are found to affect the rank order of individuals, as in a correlation coefficient.

This lecture will review the nature-nurture controversy and the results of several recent studies of biological families, adoptive families, and twins of various ages. There are three general conclusions: (1) that IQ levels and

cognitive skills are quite malleable; (2) that the relative standing of a person in his intellectual peer group depends more on genetic than environmental differences, given rearing conditions in a humane range; and (3) that the major source of differences in intellectual performance between blacks and whites is not genetic differences. These results will be discussed in light of contemporary population biology, developmental theory and behavioral genetics.

Today I will be a projective test for many of you. Depending on your ideological preferences, you will probably be able to find some support for your existing views in what I will say. There are findings for malleability and against racial differences to please the environmentalists; genetic individual differences and some social class variation to warm the hearts of the hereditarians among you. Whatever your persuasion of the moment, you are likely to be both pleased and dissatisfied by the lecture. The polarization of views has largely prevented intellectually honest, public discourse on issues of nature and nurture. It is my hope that the ideologues of both sides can leave here today with some cognitive dissonance and a grudging acceptance that we have made some progress in understanding human behavior.

Each generation of psychologists rediscovers the nature-nurture problem. Contemporary students of the issue have been handicapped, however, by a chasm in intellectual history between the present group of middle-aged, behavioral scientists, who ruled the issue out of polite discourse, and older generations of scholars, who actually did research on the problem. Those of us who were educated in the 1950's and early 1960's were taught, for the most part, an environmentalism-run-amok. From the mid-1960's, the nature-nurture problem took on new life, but, alas, few of us were in contact with the wisdom of earlier generations.

To rediscover what used to be widely known about nature and nurture, let us examine some wisdom in Woodworth's classic book (1941)(pp. 30-31).

"These two statements--(1) that differences in environment can produce substantial differences in intelligence, and (2) that differences act-

ually present in a community are not due mostly to differences in environment — may appear mutually contradictory. That they are not contradictory has been emphatically pointed out by several students of the nature-nurture problem. For example:

Shuttleworth (1935): 'The data of Burks indicate very clearly that inter-family environmental differences account for a much smaller proportion ... of the variance ... in intelligence than do hereditary differences .... The inferiority complex which many educators and environmentalists have created for themselves by the misinterpretation of these and similar data is a most bizarre phenomenon. It does not follow that the general level of the environment is a relatively unimportant factor in determining the general level of intelligence, but only that environmental differences are relatively small in comparison with hereditary differences in determining individual differences in intelligence. Even if environmental differences accounted for zero percent and hereditary differences accounted for 100% of the individual differences in intelligence, it would still be true that the general level of the environment would be a most important factor determining the general level of intelligence.'"

Although Woodworth and Shuttleworth directed their comments to intelligence, the same principles apply to all of human behavior; i.e., learning, personality, social behavior, and so forth. The determinants of differences in behavior are not necessarily the determinants of development. This is the first issue that I want to address. The second issue is malleability, and the third is individual versus group differences. Last, I want to review some of the recent findings of family studies on the sources of individual

and group differences in behavior, especially as they illuminate the effects of variations in our rearing environments.

Differences versus development

For mysterious reasons, there is quite a psychological literature that asserts that it is useless to try to separate the effects of genes and environments as sources of human differences because both are required for development. That statement is a secondrate non-sequitor. Of course, both genes and environments are required to program the development of the organism, including behavioral development. It is no accident that all human brains and behaviors have more in common with each other than any human has with any other species. Ernst Mayr (1970) has eloquently described an evolved genetic program for development that is largely shared by all species members. Individual differences among us are minor variations on the species theme.

Individual differences may arise from these minor variations in our genetic program, and they may arise from differences in our rearing environments. As Waddington, the great British biologist, has pointed out, development is the process by which genotypes come to be expressed as observable phenotypes, including behavioral phenotypes. For a genotype to be expressed, an environment is required. Differences in those environments may create differences in even the same genotype, although for many purposes variations in our environments may only be apparent differences with substantial effects, a theme I will return to later in the lecture. At present, the major point is that either genetic differences or environmental differences or both - during development - are responsible for the varied behaviors we observe. Whereas both are required for development to occur at all, either or both may cause differences among individuals.

Malleability

There is another mysterious myth abroad in the land concerning the fixed effects of genes on what we observe and measure. "If it's genetic (whatever that means), it can't be changed." Nonsense! As we all know from the psychological literature and from personal experience, big changes in environments, especially from deprived or abusive ones to environments in the normal range, have big effects on children's behavior. Recent reevaluations of Head Start (Zigler, 1977; Palmer, 1977) now show substantial effects of the program on later learning. Arthur Jensen (1977) has recently shown that the rural Southern environment of many Blacks produces a substantial, cumulative deficit in their intellectual functioning. Since development is controlled by both the genetic program and the environment, then changes in one or the other can alter the course of development. Behavioral changes that occur in response to environmental changes we usually call malleability or plasticity in development.

The findings of genetic sources of individual differences in behavior does not imply that environmental changes will have little or no effect. When genetic differences among individuals account for, let's say, half of the variance, then redistributing the environments that were actually sampled in the study can have huge effects. More importantly, introducing new environments or those that were not sampled can have unlimited effects.

In another brief return to the wisdom of the past, listen to what Thorndike said in 1914.

> ... Many disagreements spring from a confusion of what may be called absolute achievement with what may be called relative achievement. A man may move up a long distance from zero and nevertheless be lower down

> than before in comparison with other men who have moved up still farther. The commonest error ... is that of concluding from the importance of ... heredity that education and social control in general are futile .... To the real work of man for man, -- the increase of achievement through improvement of the environment, -- the influence of heredity offers no barrier. (Woodworth, pp. 30-31)

As Thorndike clearly understood, levels of behavioral development are malleable. Improvements in environments will improve phenotypes. And he also highlighted a second principle of malleability: that individuals respond differently to those improvements. Individuals, we now believe, have genetically different responses to similar environments. This genetically-different responsiveness has been called the range of reaction. As Irving Gottesman (1963) has explained it, range of reaction means that each individual has a range of possible developmental responses to a range of environments (in other words, each of us will have better or worse phenotypes, depending on our environments), but different people will not have the same response to the same environment. Malleabilbity does not mean that we will all end up alike. Common sense and a lot of animal studies with different strains and breeds confirm this simple principle.

Thus, there are two principles of malleability: (1) that genes do not fix behavior, but establish a range of probable responses to environments, and (2) that individuals vary in their repertory of possible developmental responses. Thus, the level of performance or adjustment, or whatever, is responsive to the environments in which people are reared, and yet individuals will still differ from others reared in similar environments.

Genotype environment interaction and correlation

Before I leave the topic of malleability, let me digress briefly into a discussion of two misunderstood corrolaries of the principles I just described. These are gene-environment interaction and gene-environment correlation. As I have said, every individual has a unique responsiveness to an environment. Some environments are probably better than others for everyone; thus, although people will differ in the degree of their responses, they will all be better off with the same change. In this case there is no gene-environment interaction.

There are other cases where some individuals respond better to one environment and others respond better to another. That is what is meant by gene-environment interaction; for example, PKU is really an example of gene-environment interaction because the brains of children with the deficient enzyme are poisoned by the phenylalanine in an ordinary human diet. Normal children, with the enzyme, require phenylalanine as an essential amino acid in their diets, and will develop much worse without it. As you can see, PKU is a case where a few children develop better in an environment free of this amino acid, whereas the vast majority of children develop better in an environment with it. I suspect that some of the research on optimal stimulus environments can be seen similarly; although most children flourish in a varied and rich stimulus environment, some may require less variety to be effective learners and copers. This is another possible case of gene-environment interaction.

Gene-environment correlations are quite another matter. As Plomin and his colleagues (Plomin, DeFries and Loehlin, 1977) have recently described this correlation, there are active, interactive and passive versions. In the active case, a person's genotype, or his particular combination of genes,

may cause him to develop in certain ways and also cause him to seek out some aspects of his environment and not others. Anecdotes about musically talented people who doggedly find ways to express their talents, while ignoring opportunities to play baseball, are examples of this phenomenon. Children who read well are likely to go to the library more often than those who don't read well; people who are skillful at sports are likely to spend more time on the field, courts or track. The notion of an active gene-environment correlation is that we all make choices of stimuli in our environments and that our choices have something to do with our genetic background, as translated into our phenotypes, through development.

The interactive version depends on different genotypes evoking different responses from their social and physical environments. We all know that restless boys get punished more often than most girls in school, and that very shy people receive less social reinforcement than more sociable people. These are some ways in which individuals evoke different responses from others by virtue of their partly-genetic differences.

The passive version of the gene-environment correlation comes about through our relatives, with whom we share both genes and environments. Parents who are bright transmit their genes to their offspring, and parents usually provide the offsprings' environment as well. To the extent that bright parents provided intellectually more stimulating environments for their children, there is a correlation between the offsprings' genes and environments. Contrary to most of my peers in behavioral genetics, I suspect that most of what we observe in studies to be genetic or environmental effects could be better seen as gene-environmental correlations of the active, interactive and passive sort. Although I will elaborate this idea later, let me say now that much of the

naturally-occurring variation in environments that we as behavioral scientists study may be better seen as gene-environment correlations, in that people do select and evoke from their environments and parents do determine, at least in the early years, what their children are exposed to.

Individual versus group differences

The next step in this torturous path through basic concepts is the explosive issue of group differences. Is it possible that there are genetic differences in behavior among races, sexes and social classes? The answers to this hypothetical question is, of course, yes -- it is possible. How likely is it that individual genetic differences aggregate in groups to create average differences between groups? My response is that it depends on how the groups are formed. In the case of race, I will argue that group differences are unlikely and that I know of no evidence that there are genetic differences. On the contrary, the tests of the hypothesis that I have been able to make indicate that there are no genetic differences between U.S. blacks and whites in IQ, personality or any other behavior. On the sexes, I can only speculate, and I will resist that temptation. On social class groups, I think we have some interesting data in the family studies about the relative effects of social class differences among biologically-related and adoptive families that lead to the conclusion that much of what we assume to be environmental differences among people in different portions of the social structure may well be primarily genetic differences, once the environments meet some minimal levels of adequacy. But more about this in the data part of the paper.

The a priori probability of genetic differences among social class groups is far higher than the probability of differences among the races, because races are relatively closed breeding groups (relatively greater endogamy than

exogamy) with little mobility among them, so that genetic variability remains within the group and does not accumulate among groups. Social class groups are partially reformed in each generation, because individuals are mobile, upwardly and downwardly, depending in part on their individual characteristics. To the extent that genetic differences in behavior are implicated in those characteristics, then people with certain genetic differences accumulate in portions of the social structure, and their offspring inherit in part the parental characteristics. This synopsis of Herrnstein's views does not imply that I agree with a strong version of the meritocracy argument, only that to some extent, however small, Herrnstein has to be correct about social class groups.

The new wave of Family Studies

Now that we have examined some of the basic concepts for the research I will report, let me expand the context of the studies. Methodologically, they are behavioral genetic studies. Behavior genetic methods have long included the study of genetically and environmentally related and unrelated people (and mice, dogs, etc.). The contrast of effects from similar and different treatments on similar and different genotypes has been a continuing fascination for the field. Families are the usual source of human beings aggregated in related groups. Fortunately for behavior genetic studies, there are also families who are genetically unrelated but aggregated through adoption. Also beneficial to the field has been the tendency of human populations to produce occasional litters of offspring, some of them genetically identical and others no more alike than sibs. Adoptive families and twins offer unique but different opportunities to study the effects of genes and environments on the outcomes of offspring. I will not discuss the vast twin literature on

MZ-DZ comparisons today. Robert Nichols has recently reviewed it in his invited address at APA last year (Nichols, 1976). The confluence of behavior genetic and social science methods will provide new insights into true environmental effects.

An elegant way to obtain an estimate of the "true" environmental effects of family background would be to use identical twins reared apart in uncorrelated environments. Genetic differences would be controlled, while both within-and-between-family environmental effects are free to vary. Unfortunately, we child-development experts have exposed the psychological hazards of giving away one of a pair of twins, and there are simply too few cases, too peculiarly sampled, to make these subjects useful to social science.

Adoptive Families

Adopted children, on the other hand, are almost as useful as the rare identical twins reared apart, and far more available. To study the effects of above-average environments on the average levels of intellectual and personal functioning of the adopted children, one needs data on both the adoptive family environments and on the biological parents of the adopted children. Based on the intellectual levels of the biological parents, for example, one can predict the average outcome of their offspring and estimate the average effects of environmental improvements offered by the adoptive families. Scanty as the data are on the natural parents of the adopted children, they are highly suggestive, as we shall see.

Adopted children are also ideal for studying the effects of environmental differences on differences in intellectual and personal outcomes of the children. Adopted children are not genetically related to the family of rearing, so that environmental differences between families are not confounded with genetic differences in the children, if the adopted children are randomly placed by adoption agencies. (As you will see, the agencies do match natural and a-

doptive parents' background, but fortunately the information they have is sufficiently limited that they cannot bias adoption studies too much.) In principle, regressions of adopted child outcomes on adoptive family characteristics will provide genetically unbiased estimates of true, measured environmental effects in the population. And correlations between unrelated relatives will measure the total effects of shared family background. Unfortunately, adoptive families are selected by agencies for being average in many virtues, including socioeconomic status. Thus, they are always an unrepresentative sample of the population to which one would like to generalize. Although it is possible that the adoptive family regression coefficients on background are good estimates of the population values, it is difficult to know without modeling the way in which the families were selected. Easier correctives for the possible selection bias are to study adoptive families with their own biological chilren or to have a comparison sample of biologically-related families that are similarly selected.

The studies to reported in this paper include both adoptive families with their own children and biologically-related families that are very similar to the adoptive families.

The Minnesota Studies

In collaboration with Professor Richard Weinberg of the University of Minnesota and the Minnesota State Department of Welfare, two adoption studies were launched in 1973, one of black and interracial children adopted into white homes and the other of white, 16 to 22 year olds adopted in the first year of life. The first study was designed primarily to test the hypothesis that the sociocultural milieu of middle to upper-middle class families would improve the performance levels of socially-classified black children on IQ

tests and in school. For the purposes of this report, only the 111 children adopted before 12 months of age will be discussed.

The second study of adolescents was designed primarily to assess the cumulative impact of family environments at the end of the child-rearing period. If the average levels of family environments have lasting impact, it ought to be most clearly discernible in late adolescence. If differences among family environments have lasting impact on individual differences in intellectual and personal functioning, the study of adolescents adopted in the first few months of life should reveal those differences.

Methods

I. Transracial Adoptive Study

The Families

The 101 participating families were recruited through the Newsletter of the Open Door Society and by letters from the State Department of Public Welfare Adoption Unit to families with black adopted children, 4 years of age and older, who were adopted throughout the state of Minnesota.

Of the 136 families known to be eligible for participation in the study, 74% did participate.

The 101 participating families included 321 children 4 years of age and older: 145 biological children and 176 adopted children of whom 111 were adopted in the first year of life.

All of the adopted children were unrelated to the adoptive parents. Adopted children reared in the same home were unrelated, with the exception of four sibling pairs and one triad adopted by the same families.

The sample of families live within a 150-mile radius of the Twin Cities (Minneapolis-St. Paul) metropolitan area. Although nearly all of the children

were adopted in Minnesota, 68 were born outside of the state. Through interstate cooperation, the child placement agencies arranged for the adoption of many nonwhite children from other states.

Procedures

Most of the information was obtained directly from members of the adoptive families. Some additional data on the natural parents and the children's preadoption history were obtained by State Department of Public Welfare personnel from the adoption records. Achievement and aptitude test scores were supplied by school districts for all of the school-aged children to whom such tests had been administered.

The IQ Assessment

Both parents and all children in the family over 4 years of age were administered an age-appropriate IQ test as part of an extensive battery of intellectual, personality, attitudinal, and demographic measures. Children under 4 years of age were excluded because IQ tests are less predictive of later IQ at younger ages. The tests were administered in the family home during two visits by a team of trained testers.

Both parents and all children 16 years of age and older were administered the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1955). Children between 8 and 15 were given the Wechsler Intelligence Scale for Children (WISC; Wechsler, 1949), and children between 4 and 7 were administered the Stanford-Binet Intelligence Scale, Form L-M (Terman & Merrill, 1972).

All scoring of protocols and computations of IQ scores were done by a graduate student with extensive experience in administering and scoring IQ measures. This student had no contact with the families and with the examiners except to clarify questionable responses. In no case was the scorer aware of the child's race or adoptive status.

II. The Adolescent Study

The Families

The 845 subjects in this sample are members of 120 biological and 104 adoptive families in Minnesota. The adoptive sample reported in this section is limited to those 150 of the 194 adopted children who natural mothers' educational levels were available from the records of the Department of Public Welfare (DPW). Adoptive families were recruited through the DPW, whose Director sent letters on behalf of the study to 1,620 families who had adopted children between 1953 and 1959. We were particularly interested in families who had adopted at least two children, children between the ages of 16 and 21 at the time of testing. Of the 798 families known to be eligible to participate, 471 lived close enough to come into the University for a half-day testing session and were willing to do so. Many of those who refused lived far across the State and were unable to join the study. Others did not choose to subject themselves to such extensive scrutiny. The final interview sample consisted of 110 families who came to the University; the remainder participated in the mail sample that will not be discussed in this paper.

To check on the representativeness of the sample recruited for the study, we compared the socioeconomic characteristics of participants and non-participants at the time of adoption. Since we had no data on the non-participants in later years, this was the best comparison we could manage. There were no age, income, educational, occupational differences between participants and non-participants at the time of adoption, but, of course, there may be some current differences in the outcomes of their adoptions or family life histories that we are unable to detect by this method, but we believe the interview sample to be representative of white adoptive families with late adolescents in Minnesota.

The biological families were recruited through newspaper articles and advertisements, word of mouth, and the adoptive families. Approximately 153 biological families came from public media and about 41 from recommendations of the adoptive families. Of these, 122 came to the University for the full evaluation.

All families who participated in the interview procedure received small payments for their time and transportation and bonuses for recruiting other families. The data were collected from July 1974 to June 1976.

A crucial methodological consideration for any adoption study is the age at which the children are placed with their adopting families. Only early placements can guarantee that potentially confounding, early environmental experiences are minimized. All of the adopted children in this study were in their homes before 12 months of age. The mean age of placement into the adopted children's present homes was 2.6 months.

Procedures

Subjects in the adolescent family sample were administered a 3-hour battery of test and interviews at the University of Minnesota as part of a behavior genetic study of intellectual, personality, and attitudinal similarities within families. The data to be reported here are from the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1949), an individually-administered IQ test, the Holland Interest Styles (Holland, 1973), and the California F-Scale (Adorno, Frenkel-Brunswik, Levinson, and Sanford, 1950). Four subtests of the WAIS were administered: vocabulary, arithmetic, block design, and picture arrangement. The combination of these four subtests has been shown to correlate above .90 with the full scale test score and is generally accepted as a shortened version of the adult test (Doppelt, 1956). The test protocols

were scored by an experienced psychometrician who was unaware of the respondents' adoptive status.

After scoring all of the WAIS's, we became aware of a substantial sex difference on 3 of the 4 subtests, a fact seldom reported in the literature, but of which the Psychological Corp. seems to have been aware for some time (David Herman, personal communication).

IQ Level Results

Transracial Family Characteristics

The adoptive families who participated in the transracial study can be characterized as highly educated and above average in occupational status and income. The typical occupations of the adoptive fathers were clergyman, engineer, and teacher. Nearly half (46.5%) of the adoptive mothers were employed at least part time, typically as teachers, nurses, and secretaries.

Insert Slide 1 about here

The mean educational level of the natural parents was high school graduation, which is close to the median for that age cohort of the general population. Actually, the black mothers had one year less education than the black females in their age group (25-44). Fathers of the early-adopted black children had slightly more. Slide 1 shows the average educational level of the white mothers of interracial black children, the black mothers, and the black fathers, compared to local and regional norms. (Because there were only two white fathers of interracial children, they have been omitted from the table.) From this we infer that the natural parents were intellectually average for their populations.

Insert Slide 2 about here

IQ Scores of Adoptive Parents

As indicated in Slide 2, the mean WAIS IQ scores of the adoptive parents were in the high average to superior range of intellectual functioning. The distribution of scores extends from the low average to the very superior, with considerable restriction of range. The scores were congruent with the very high educational level of the group.

Insert Slide 3 about here

IQ Scores of the Natural Children of the Adoptive Parents

The mean IQ scores of the natural children of the adoptive families were in the high average to superior range of intellectual functioning. As expected from polygenic theory, when both parents have high IQ scores, there is less regression toward the population mean than under conditions of random mating. Slide 3 gives the Stanford-Binet, WISC, and Wais results for the natural children. Only the Wechsler scores had a restricted range. With tests combined, the total IQ score ot the natural children averaged 116.7 with a standard deviation of 14.0.

Insert Slide 4 about here

The IQ Scores of Adopted Children

The mean IQ scores of the adopted children were in the average range. As shown in Slide 4 the scores on the three IQ tests, although for children at different age levels, were highly comparable. The adopted children did not perform as well as either the adoptive parents or their biological children, although those adopted in the first year of life (the Early Adopteds) averaged IQ 110. For black and interracial children with average biological parents, IQ 110 represents at least a 15 point difference from children of similar background reared by their own parents.

School Achievement

The IQ assessments of the present study should bear a meaningful relationship to school achievement. Slightly above average IQ test performance should predict to slightly above average school achievement. The school data are also important because they come from many different school districts and are uncontaiminated by any biases that may have inadvertently influenced testing in our study. Most importantly, they represent a "real-life" criterion of intellectual achievement.

Insert Slide 5 about here

Slide 5 gives the mean national percentile scores for vocabulary, reading, and mathematics achievement, and a total aptitude score expressed in IQ form, for the socially classified black adopted and natural children of the adoptive families. Although the sample sizes were rather small, the black children in school were performing slightly above the national norms on standard scholastic achievement tests, just as their IQ scores would predict. By contrast, the average black child in the Minneapolis schools is scoring at the 15th to 20th percentile on reading and mathematics tests.

The natural children of the adoptive parents scored higher than the adopted children in scholastic achievement tests, as predicted by their individual IQ test scores and their school aptitude scores. The correlation between the individual and group test scores of the 39 natural children was .78 ($p < .001$).

Adolescents' Family Characteristics

The socioeconomic characteristics of the biological-related and adoptive families with adolescent children are well above the averages of their cohorts

in the population. The occupational prestige of the fathers, rated on the NORC (Reiss, 1961) is about 60 in both types of families. Since less than half of the mothers were employed, their occupational ratings were not used in the analyses. Family income averages $25,000 to $26,000 in both types of families. The variance of the educational, occupational and income measures is not as restricted as the means might imply. In fact, the standard deviations are roughly comparable to the population figures. Two points should be made, therefore, about the socioeconomic characteristics of these families; first, the adoptive and biological families are fairly comparable, and second, they both represent selected portions of the SES range. It is well known that volunteers in social science research are self-selected for better-than-average characteristics of all kinds, and the sample of biological families is at least as biased in SES characteristics as the adoptive one. This is what we hoped would happen, without the statistically hazardous procedure of matching individual families.

Insert Slide 6a about here

IQ Scores of Adoptive Parents

The adoptive and biological parents are also comparable in mean IQ scores and in the variance of their scores. Compared to the standardization sample for the WAIS (Wechsler Adult Intelligence Scale) the fathers are more than a standard deviation above the mean and the mothers about 3/4 of an S.D. above. It is not accidental, of course, that samples with above-average income, education and occupational status also score above the average on a standard IQ test. The standard deviation of the parental IQ scores in only 3/4 of the population standard deviation, a significant restriction. Their scores are

significantly restricted in range, with the lowest scores in the mid-90's, as shown in Slide 6a.

Insert Slide 6b about here

IQ Scores of the Adolescents

The children of the two types of families are quite comparable in age, the mean being about 18-1/2 in both groups. The range of ages is 16 to 22 in both groups (with a few 15 and 23 year olds). The IQ scores of the adopted children are about 6-1/2 points lower than those of the biological children, however. These results are also shown in Slide 6b. If IQ is heritable to any extent, one should expect the biological offspring of bright parents to have higher IQ scores than unselected people.

The adopted children are not a genetically selected group. Their natural mothers average 12 years of education at an average age of 41 at the present time. The median educational level for women, aged 25-44 in the Minnesota area is 12.5 years of education. Education is an indirect measure of intellectual ability, but as we have shown in another study, there is good reason to expect that intellectual level of the natural mothers is reasonably well indexed by their educational levels (Scarr & Weinberg, 1976, 1977a, 1977b). Furthermore, in the large study of unmarried mothers in the state of Minnesota during the years 1948-52 when IQ tests were mandated for all women giving up children for adoption, the average IQ score of 3600 women was 100.00 with a standard deviation of 15.4. Since our mothers were sampled from 1953-59, there is no reason to expect them to differ significantly from the normal population. Fathers, of course, should not be expected to deviated from the average of the population any more than mothers. Thus, the adopted children

are genetically an average sample of the population, while the biological children are more selected. What, then, do we conclude from the IQ levels of adopted children? From the average IQ scores of 110 for the transracial adoptees and 106 for the adolescent adoptees, we conclude that adoptive family environments have increased the scores of genotypically average groups by 5 to 15 points. This result is congruent with past adoption studies. But the higher IQ level in better environments is also congruent with a large genetic effect on individual differences among the adopted children; as we shall see.

Individual Differences in IQ

First, let me talk about individual differences in IQ. As Jencks and Brown (1977) have indicated, there are two basic approaches to estimating the importance of environmental differences for differences in outcomes. First, they say, one should begin by offering some meaningful definition of what one means by environment. One strategy is to specify what one means by measured environment and study the effects of differences in home background on unrelated children adopted in the homes. The second strategy is to look at all those environmental influences shared by children reared together. One can estimate the contribution of total family background to differences among children by calculating the correlation between the phenotypes of genetically unrelated parents and children and children reared together. These two behavior genetic strategies — the regression of children's IQ scores on measured family background and the correlations of genetically related and unrelated family members -- will be reported in that order.

Insert Slide 7 about here

Regression of Adolescent IQ Scores on Family Characteristics

The major concern of the adolescent study is with the predictability of children's intellectual outcomes from environmental differences among their families. I will deal with those results first. In the first set of equations, shown in Slide 7, father's education, occupation, mother's education and family income were used to predict the child's IQ. In the biological families parental education and family income are positive coefficients, and father's occupation is negative. The total R^2 for the regression of biological children's IQ scores on their families' demographic characteristics in this sample is .107.

The total R^2 for the adopted child regression on the same variables is much lower, only .019. The positive coefficients on parental education are lower than those in the biological family regression, family income is slightly negative and father's occupation is moderate and positive.

When birth rank and family size are added to the equation, the R^2's for both the biological and adoptive children increase by about .04 to .145 for the biological offspring and .059 for the adopted children. Family size is a larger negative coefficient for biological children's IQ scores than for the adopted, because of the negative correlation of family size with the biological families' demographic characteristics. The coefficients on the demographic characteristics in biological families are reduced slightly when birth rank and family size are added. In the adopted families, the demographic coefficients are slightly reduced, except family income, which is pulled from slightly negative to slightly positive by the addition of birth rank and family size. Birth rank has a higher coefficient for adopted children's IQ than for biological, thereby demonstrating it is entirely a social effect within families.

The addition of parental IQ scores has dramatically different effects on the regression equations in the biological and adoptive families. First, the R^2 for biological children's IQ scores is doubled to .309, whereas the R^2 for adopteds is increased by only .016, to .075. This striking difference in the overall effects of adding parental IQ to the equation must reflect the genetic contribution of biological parental IQ to their offsprings' IQ scores. There are also striking changes in the coefficients on biological family demographic characteristics once parental IQ has been added. Father's educational coefficient drops to 1/3 its former value, and mother's education is pulled to a negative coefficient, because parental education is a measure of intellectual level that is transmitted to the biological children genetically. Birth rank and family size coefficients remain virtually unchanged, however. The addition of parental IQ to the adopted children's regression changes the demographic coefficients very little.

The addition of natural mother's education, age and occupation doubles the R^2 for the adopted children, from .075 to .157. The coefficients on adoptive family demographic characteristics are reduced, reflecting a degree of selective placement. It is natural mother's education that contributes most to the changes in the equation. Because natural father is in most cases unreported to the adoption agency, there are too few data of the fathers to include in the major analyses, but it is interesting to note that when father's education is averaged with mother's, the biological parents are powerful predictors of the adopted children's rank order of IQ scores (Slide 8).

Insert Slide 8 about here

Although there are only 21 cases with complete information, the regression coefficient for natural parents' education is statistically significant, with an R^2 of .26, and a simple correlation of .51. Adoptive midparent education adds little to the R^2, although it has a simple r of .19 in this subsample and a larger variance than natural midparent education. Selective placement of the adopted children for whom the educational levels of both natural parents were known to the agency was .27. After a natural midparent education is entered into the regression equation with a beta coefficient of .50, adoptive midparent education has a beta of only .06.

While limited, these data strongly suggest that individual differences in IQ among the adopted children are much more conditioned by their genetic differences than by differences in their social environments, within the range of social environments sampled by these adoptive families.

Insert Slide 9 about here

The sample of adopted children with parental information can be increased by dropping the natural fathers. Slide 9 gives the regression of child IQ on adoptive midparent education and natural mother's education. Note, first, that the simple r of natural mother's education in this sample of 74 cases is .29 with child IQ, and that the correlation of adoptive midparent education is .28, instead of .19 in the 21 cases. The variance of adoptive parents' education is larger than that of natural mothers'. The regression coefficients are close in magnitude, and the beta's .24 and .22 for the natural mother and adoptive parents, respectively. In this regression equation, both biological and adoptive parents' education make a significant contribution to the children's IQ differences. The coefficient

for natural mothers alone is still higher than that for the average of the adoptive parents, however.

Insert Slide 10 about here

For comparison, let us look at the sample of young, transracially adopted children. The adopted and natural children of the same parents have very different regression equations of IQ on family characteristics. Slide 10 shows that the R^2 for the biologically-related children is nearly twice that of the children adopted in the first year of life. In fact, the total R^2 for the biological children at an average of 10 is surprisingly like that of the 18 to 19 year olds in the adolescent study: .301 compared to .309. The R^2 for the young adopted children at an average age of 7 is higher than that of the adolescents: .156, compared to about .04. We think this is due to the more exclusive influence of families on their children at younger ages. The magnitude of the adopted child's coefficient is close to that of Burks (1928) for children of the same age. The regression equations for family demographic and parental IQ variables in the adolescent and young adopted samples are surprisingly similar, however, in the relative magnitudes and signs of the coefficients. The regressions of biologically-related children's IQ scores on measures of their family background are found to be rather stable across samples and greatly inflated by the shared genetic variance in families.

From these equations it is evident that the regression coefficients of child IQ on family variables in studies using only biologically-related parents and children are reflecting more genetic than true environmental variance. The differences in the equations and R^2's for the biological and adoptive families are striking. And the large effects produced by adding

information about the adopted children's natural parents, who do not rear the child, strongly support the importance of genetic differences in IQ within these families.

Family Correlations

For the second approach to estimating the magnitude of true environmental effects on individual differences, we calculated family correlations. We used all of the subjects for whom IQ data were available, regardless of what other information might be missing. Thus, the samples of both adoptive and biological family members are considerably larger.

By calculating the correlations for related and unrelated family members, we get an estimate of the degree to which similarity in intellectual outcome is conditioned by similarity in the family environment. This entails a comparison of biological and adoptive family correlations. Parents and children do not share the same rearing environment, whereas siblings do, regardless of their genetic relatedness.

Insert Slide 11 about here

In the study of young adopted and biologically-related children, we found that parent-child correlations were much greater for the biologically-related pairs (yielding "heritability" estimates in the range of .4 to .7), but the sibling correlations were quite similarly high for both related and unrelated pairs (Scarr & Weinberg, 1977a, 1977b). We speculated that similarities among these young children were greatly influenced by their families' common rearing environments.

Insert Slide 12 about here

In this sample of late adolescents, we were able to check on the degree of family environmental influence at the end of the child rearing period. The results for the parent-child pairs are quite similar to the earlier study, whereas those for the siblings are very different. The adopted siblings at the average of 18-1/2 hardly resemble each other at all.

Insert Slide 13 about here

The evidence for genetic effects is striking in all comparisons of correlations among members of the adoptive and biological families. Even though the scores of both biological and adoptive family members have restricted variance, the coefficients for the biological family pairs usually exceed those of the adoptive family members by a statistically significant amount. As Slide 13 shows, in total IQ the biological parent-child pairs, the midparent-child and the child-child pairs are significantly more similar than the adoptive family members. Only in vocabulary are the adoptive family members similar at a level different from zero. It is no accident that vocabulary differences are most amenable to social environmental influence, since language is the mode of social exchange among human beings, genetically related or not. It is also not surprising that the skill most amenable to mate selection (assortative mating) and successful marriages is vocabulary. Evidently, married couples spend some time talking to each other, but are not as concerned with other intellectual skills!

From these family correlations one can calculate the differences between the adoptive and biological correlations and, depending upon the model, the "heritabilities." Genetically related persons in ordinary families share about half of their genes. Unrelated people share none of their genes, except

through the selective placement of adopted children for IQ, of which there is only slight bias in this study. Even though they have always lived together, the correlations of adoptive fathers' and mothers' IQ with adopted children's IQ scores are .16 and .09 respectively, so that there is little evidence for either selective placement or social environmental influence on IQ differences.

From these data one can calculate the difference between the IQ correlations of biological and adoptive relatives and the "heritabilities," based on a simple-minded model: doubling the difference between the correlations of biologically-related and unrelated pairs and adjusting for assortive mating. This naive model throws the genotype-environment covariance (if any) into the genetic term, because only biologically-related parents transmit both genes and environments to their offspring. The environments that the parents provide are correlated with their own genes and with the genes they transmit to the offspring. The "heritability" terms calculated here are really additive genetic variance plus GE covariance in the parent-child comparisons and broad heritability (including some dominance) in the sibling comparisons. The inexactitude of the measures, however, makes this distinction academic, in all probability. (See Slide 14)

Let us focus on the total IQ score, for several good reasons. First, the other tests are parts of this larger whole. Second, the subtests are far less reliable and less variable than the total score. And, last, the meaning of the whole is greater than the parts taken singly. It is also clear that total IQ has the highest heritability as estimated from the parent-child correlations (.55 is the average of mother-child and father-child comparisons) and from the sibling comparison, .76. These results lead to the same con-

Insert Slide 14 about here

clusion reached earlier from the regression of child IQ on the family background and parent IQ data; namely, that half or more of the contribution that parents make to differences in their offsprings' intellectual level is genetic.

We have resisted so far, from ignorance and fear of some formidable critics, the temptation to analyze our data in more sophisticated ways. We cannot defend all of the assumptions that must be made to justify elaborate models, and therefore have hesitated to throw ourselves into an inevitable fray. Nonetheless, it seems evident to us that the study of adoptive and biological families provides extensive support for the idea that half or more of the long-term effects of "family background" on children's intellectual attainments depend upon genetic, not environmental, transmission. Furthermore, in the range of environments sampled in this study, there is little evidence for any measured environmental effects in "family (SES) background."

In saying this, I am commenting only on the lack of differences among family environments. The only variable that differs among siblings in our study is birth order. Birth order is the only variable with substantial effects in the adoptive families, accounting for about 4 percent of the IQ variation among the adolescent children, and 2 percent among the younger children. It may be that other environmental variables affect only one person within a family. If there is explainable, predictable variance for individuals, we have not measured it. Our comments about the lack of environmental effects pertain to those characteristics shared by family members, such as SES, neighborhoods, schools, community, etc.

Other Current Family Studies of Intelligence

Most of the other studies I want to discuss are ongoing and still in the data-collection phase of the research. Therefore, there are few results to

report. But here are a few.

Texas Adoption Project: The design of the Texas project included the natural mothers' IQ scores, which were available because the sample was obtained from a home for unwed mothers that gave IQ tests as part of their effort to counsel the young women. At last report, they had studied about 300 adoptive families containing one or more of the children born to the unwed mothers. Many of these adoptive families also have their own children. Although the investigators, Horn, Loehlin and Willerman are not ready to publish their results, they kindly shared the following table of family correlations.

Insert Slide 15 about here

As I understand from previous discussions with them, there is considerable restriction of range in the IQ scores of all family members, so that the correlations you see are uncorrected for restriction of variance to half or less of that in the normal population. Thus, the correlations should all be higher. The overall pattern of results generally confirms the biological hypothesis, with one peculiar exception: The adoptive mothers' IQ scores are as highly correlated with their adopted as biological offspring. I understand from Willerman that path analyses of the entire pattern of correlation is yielding "heritabilities" of .3 to .4, under what assumptions I don't know.

Also from previous reports on a smaller sample, I understand that the average IQ level of the adopted children is about 108, as is that of the biological parents, the adoptive parents and their natural children. We will have to await their results on the larger sample.

Insert Slide 16 about here

Family patterns of learning disabilities: In the published literature, there is one excellent study of family patterns of reading disabilities, an SRCD Monograph by Freya Owen and colleagues in the Palo Alto school district and a group at Stanford University (Owen, Adams, Forrest, Stolz, and Fisher, 1971). They showed that children with reading levels far below their intellectual level were more likely to have reading impaired siblings and parents, particularly fathers. Now, Gilbert Omenn, the President's new Deputy Science Advisor, has shown that verbal and auditory patterns of reading disability run in family lines (Omenn & Weber, 1977). As the following table shows, one is far more likely to find a pattern of dysphonetic spelling errors, mispronunciations and auditory reading problems in some families and phonetic spelling errors and visual reading problems in other families. This line of research is also being followed for stuttering by Kenneth Kidd at Yale, for learning disabilities by John DeFries and colleagues at Colorado, and doubtless for other problems elsewhere. Tracking down the transmission of particular problems and particularly being able to divide them into diagnostically meaningful categories that show consistent lines of transmission in families seems useful and informative.

The Hawaii Family Study: A collaborative group from the Universities of Hawaii and Colorado are conducting a very large study of biological families in the multi-racial population of Hawaii. The preliminary results, already published, show that the same intellectual factor structure exists in all groups. The folowing slide shows that family correlations are of similar rank order magnitude in general, within the European-American and Japanese-American groups, although the AEA group tends to have greater parent-child resemblance in this battery of measures. No mean data have been published as yet.

Insert Slide 17 about here

Other cognitive skills: Patterns of family correlations that would indicate a sex-linked recessive gene for the enhancement of spatial visuallizing ability had been proposed by Stafford, Bock and his collaborators to explain the large average difference in spatial abilities between men and women. More recent family studies have failed to support the genetic hypothesis about sex differences; Bouchard & McGee (in press) and Carter-Saltzman (1976) independently found no such pattern of correlations. Carter-Saltzman, Scarr & Weinberg further found that adoptive family members do not resemble each other in spatial or other cognitive abilities above a chance level, whereas the biological relatives usually correlated above a chance level.

Other Family Studies: Other family studies are in progress in Colorado, (a prospective adoption study design) and doubtless elsewhere. We should look forward to increasing numbers of studies that take both genetic and environmental similarity into account before assigning causal statements to their results.

Similarity in Vocational Interests and in Adoptive and Biologically-Related Families

Lest you think we are stuck on IQ, let me remind you that genetic relatedness in families is not, of course, specific to measures of intellectual ability. Whatever traits are affected by genetic differences are more similar for related than for unrelated people. As part of the study of adoptive and biologically-related families with adolescent offspring, we administered to the parents and children several tests of interests and personality. Let me mention the interest results. The measurement of vocational interests is

well-developed in psychology, but not until recently has there been a theoretical approach to the relationship of interests to performance on the job. Holland (1966, 1973) has conceptualized work environments and people's orientation to work environments in six categories that he calls interest styles.

Holland's interest styles may be briefly described as follows: realistic (practical, rugged, aggressive persons who enjoy working outdoors and with their hands); investigative (scientifically oriented persons who enjoy thinking through problems); artistic (self-expressive and creative persons); social (responsible, humanistic, or religious persons concerned with the welfare of others); enterprising (persons who enjoy selling, dominating, and leading); and conventional (persons who prefer highly ordered verbal or numerical activities).

Although the full report of the results will be made elsewhere (Grotevant, Scarr & Weinberg, in press), the data indicate first that biologically-related family members modestly resemble each other on measures of Holland's interest styles. Adoptive family members, however, are, on the average, no more similar than parents and children paired randomly from the population. These data corroborate and extend the findings from twin studies of moderate heritabilities for interests by showing that they exist across generational cohorts of related individuals as well as within cohorts of related twins and siblings.

Data from the sibling correlation comparisons confirm the lack of overall similarity between unrelated children reared together. The contrast with biological sib pairs appears to reflect genetic influences on interests, while the higher correlation of biological sib pairs than parent-child pairs appears to reflect the impact of common rearing environment.

Profile Analysis

Instead of examining family similarities on each of the six individual scales, we are reporting here the comparisons of overall profile contour (shape). Holland's (1973) model states that an individual is most clearly characterized by the rank order configuration of his six interest styles rather than by merely his highest scale score.

Insert Slide 18 about here

To compute similarity of profiles, Wilson's (1968) adaptation of the repeated measures analysis of variance was used, with pairs as a random factor and scales as the repeated measure. Using scores standardized within each distribution as input, intraclass correlations for profile contour were calculated. The intraclass correlations for profile contour or shape are presented in Slide 18.

None of the parent-parent or parent-child correlations for adoptive family pairs was significantly different from zero.

The consistent adoptive-biological difference for profile contour provides support for the hypothesis that the patterning of interests in individuals is partly heritable. Parents and children and siblings are not similar in vocational interests unless they are genetically related. Sharing the home environment does little to create similar orientations to work environments. Biological relatives are not as similar in interest patterns as in abilities, even though both measures are highly reliable. Therefore, we should emphasize that most of the variance in vocational interests remains unexplained, but of that variance explained, little of it results from modeling or learning from one's parents or siblings.

Authoritarianism Re-revisited

Let me tell you the empirical history of a control variable. The moral of the story is, "Don't count your environmental variables until they match". Once upon a time there was a study of adoptive and biologically related families with adolescent children (it should begin to sound familiar to you). The researchers, Scarr & Weinberg, wanted to include a measure that would be as similar in genetically unrelated families as in related families. What could be more likely than social and political attitudes? Naively, they chose the California F-Scale. They failed to notice in the literature the almost-buried correlations between authoritarianism, IQ and education that had usually been explained away as another manifestation of the life circumstances that also create authoritarian attitudes.

To their surprise, the hapless investigators discovered very low correlations in authoritarianism among adopted relatives and substantial correlations in the biological families, as shown in the next slide.

Insert Slide 19 about here

As you can see, the pattern of family correlations is much like those we obtained for IQ scores. This turns out to be no accident, because F-Scale scores correlate .5 with verbal ability in this sample, as in other representative samples in the published literature. (The correlation with WAIS IQ is almost as high, but WAIS vocabulary partialled out even more of the F-Scale variance).

Insert Slide 20 about here

So, we built a path model (Slide 20) for the transmission of authoritarianism in families. Our model says that there is a common basis for verbal skills and the kind of moral reasoning that is sampled by the F-Scale. In addition, there may be a non-intellective path from parent to child -- something like the personality variable that social psychologists have proposed for authoritarianism. As you can see, whatever is common to vocabulary and F-Scale scores accounts for all of the family resemblance in adoptive families; there is no additional transmission of social attitudes by direct learning of child from parent of the social attitudes called authoritarianism. In the biological families, on the other hand, there is a significant path from parent to child of personality-type authoritarianism, that must have a biological basis, because it does not appear in the adoptive families. I submit to you that these results for authoritarianism should cause us to re-think the nature of moral judgment and socio-political attitudes.

The Evidence on Racial Difference as Environment and Genes

Three recent investigations on the possible genetic origins of racial differences in performance in school and on IQ tests reject the hypothesis of genetic differences as a major source of those differences in performance. The study of transracial adoption already discussed (Scarr & Weinberg, 1976) showed that black and interracial children reared by socioeconomically advantaged white families score very well on standard IQ tests and on school achievement tests. Being reared in the culture of the test and the schools resulted in intellectual achievement levels for black children that were comparable to adopted white children in similar families. Therefore it is highly unlikely that genetic differences between the races could account for the major portion of the usually observed differences in the performance levels of the two groups.

A second study on the relation of black ancestry to intellectual skills within the black population (Scarr, Pakstis, Katz & Barker, in press) showed that having more or less African ancestry was not related to how well one scored on cognitive tests. In other words, holding constant social identity and cultural background, socially classified blacks with greater amounts of white ancestry did not score better than other blacks with more African ancestry. A strong genetic difference hypothesis cannot account for this result.

Briefly, blood groups were used to estimate the proportion of each person's African and European ancestry. This is roughly possible because the parent populations differ in the average frequencies of many alleles at many loci and differ substantially at a few loci. Therefore, if a person has a particular allele, we were able to assign a probability that he got that gene from one of the two populations. While there is undoubtedly a large error term in these estimates, they had several satisfactory characteristics, such as appropriately large sibling correlations and correlations with skin color. What is most important here, is that the estimate of ancestry did not correlate with any measures of intellectual performance in the black sample. Let us look at a scatterplot just to make sure. As you can see there is absolutely no relationship between ancestry and intellectual skills. Thus, we concluded that degree of white ancestry had little or no effect on individual levels of performance within the black group. We must look to other explanations.

Insert Slides 21, 22, and 23 about here

The third study was of black and white twins in Philadelphia. Briefly, the black 10 to 16 year olds scored half to one standard deviation below the whites on every cognitive measure. The social class differences between the

races were not sufficiently large, as Jensen has reminded us, to account solely for the magnitude of this performance difference between the racial groups. The major hypothesis was that black children have less overall familiarity with the information and the skills being sampled by the tests and the schools. By using twins in this study, we were able to examine three implications of cultural differences compared to a genetic differences hypothesis. The major predictions of the cultural differences hypothesis are:

1. Black children will score relatively worse on those tests that are more culturally loaded than on more "culture-fair" tests when the instructions for all tasks are equally understood.

2. The cultural differences of the blacks constitute a "suppressive environment" with respect to the development of the intellectual skills sampled by typical tests, and therefore black children will show less genetic variability in their scores and more environmental variability (Scarr-Salapatek, 1971).

3. Differences among black children will be more dependent on differences among their family environments in the extent to which they aid children in the development of test-relevant skills, and therefore (a) the twin correlations will be higher for black twins, and (b) there will be less difference between MZ and DZ coefficients in the black than white groups.

Three major predictions of a genetic differences hypothesis are:

1. Black children will score relatively worse on those tests that are loaded more highly on a "g" factor than on more verbal, culturally loaded tests.

2. The proportions of genetic and environmental variability will be the same in both racial groups.

3. Family environments will be no more important in black than in white racial groups in determining individual variation.

We believe that the pattern of results supports a general cultural difference hypothesis far better than a genetic differences view. The major intellectual results are:

Insert Slide 24 about here

(1) Black children have lower scores on all of the cognitive tests, but they score relatively worse on the more culturally-loaded of the conceptual tests.

(2) The cognitive differences among the black children are less well explained by genetic individual differences, by age and by social class differences than those of the white children.

Insert Slide 25 about here

(3) The similarity of the black co-twins, particularly the DZ's, suggests that being reared in different families determines more of the cognitive differences among black than white children, but that those between-family differences are not those usually measured by SES variables in the white community.

Therefore, we conclude that the results of this study support the view that black children are being reared in circumstances that give them only marginal acquaintance with the skills and the knowledge being sampled by the tests we administered. Some families in the black community encourage the development of these skills and knowledge, while others do not. In general, black children do not have the same access to these skills and knowledge as

white children, which explains the lower performance of black children as a group. The hypothesis that most of the differences among the cognitive scores of black and white children are due to genetic differences between the races cannot, in our view, account for this pattern of results. Therefore, in 3 studies the hypothesis of genetic differences between the races fails to account for the IQ performance differences.

The Evidence on Individual Differences as Genes and Environments

From this review of recent family studies, I think that the evidence for some genetic individual differences in behavior is simply overwhelming. Especially if one considers the past literature, there are literally dozens of studies that support that mild conclusion. When one attempts to get quantitative about proportions of genetic variance in IQ scores, one has to establish a range of probable values rather than any point estimate. There are several reasons for this. First, there may be real developmental differences in the degree to which environmental influences are potent determinants of individual differences. It seems to me from limited evidence that younger children may resemble their parents more on environmental grounds, because they are more exclusively influenced by their parents before they are launched into the world of schools, social institutions, and many individual choices. (Remember those active gene-environment correlations.)

Second, different cognitive skills that are sampled by different measures may be more or less environmentally influenced, such as vocabulary compared to matrix reasoning. So that different studies of different age groups using different measures may well get somewhat different results. And, third, there are all the measurement and reliability questions that pertain to any study of cognitive abilities.

Going straight to the heart of the matter, I would think that most evidence points to a "heritability" of about .4 to .7, given that "heritability" here means the proportion of variance among individuals sampled in twin and family studies, which as I have repeatedly noted are not representative of bad environments. If one could include people with really poor environments, the proportion of environmental variance might rise; on the other hand, the genetic variance might also be increased. It is hard to predict whether the proportions of variance would change or not, and in which direction.

It is important to note the lack of systematic, measured, environmental differences among the people in our family samples. This suggests that within the range of "humane environments", from as SES level of working to upper middle class, there is little evidence for differential environmental effects. The average level of these environments is such that the children perform intellectually somewhat above the population average, even though they have average biological parents. Thus, the environments sampled in family studies are better than average at fostering intellectual development. But why are the relatively poor families rearing adopted children whose IQ scores are nearly as high as those in professional families? It must be that all of these seeming environmental differences that predict so well to outcome differences among biological children are not primarily <u>environmental</u> differences, but indices of genetic differences among the parents and their biological offspring. This brings us to social class.

<u>The Evidence on Social Class Differences as Environment and Genes</u>

In 1938 Barbara Burks compared her California adopted and biological children to those studies by Alice Leahy in Minnesota. Grouping the children by the occupational status of their adoptive families, Burks computed the

average effects of being born to and reared by, or only reared by, families at different locations in the social structure. As in all adoption studies, the families do not vary over the whole SES range; in fact adoptive samples always omit those lower portions of the income and educational distributions where big negative effects can occur. Nonetheless, it is interesting to examine the overall effects of being reared by a skilled working class family, or a white collar family, or a professional family. As you already know, the intellectual levels of parents in those groups differ on the average. What about the children?

For biological children of these occupational classes, the average difference between working class and professional families was 12 IQ points in Burks study and 17 IQ points in Leahy's. Children adopted by families of the same occupational classes, however, differed far less -- about 5 IQ points in both studies. Adopted children in professional families scored below biological offspring; in working class families, adoptees scored above the natural children; a very predictable genetic outcome. In our Minnesota studies, we found that the natural children of the transracial adoptive families averaged about 6 IQ points above their adopted siblings. The adolescent adoptees averaged 6 IQ points below the biological children of comparably advantaged families. As in the other studies, there is a far greater relationship between parental social class and child IQ in the biological than adoptive families.

Since there is always some selective placement of adopted children into families that resemble their biological parents, the actual effect of differences in this middle to high range of social class environments may be less than the 5 or 6 IQ points cited. Again, let me emphasize that none of these

studies speak to lower-class, deprived, abusive or any other kind of environmental abominations. I am only saying that in that portion of the SES range where so many studies report intellectual differences among children reared in such circumstances, that the differences observed among the children may not be primarily of environmental origin at all. From the older studies, Burks estimated that genetic differences among the occupational classes account for about 2/3 to 3/4 of the average IQ differences among the children born into those classes. More recent studies suggest more than half.

Why Study Genetic Differences in Behavior?

It may occur to some of you that all of this family research sounds pessimistic. What's left to the systematic environment? (There's a lot left to random events or otherwise unexplained!)

I do not see these research outcomes as pessimistic in the slightest. On the contrary, I think these family studies permit behavioral scientists and social policy makers to sort out important differences in people's environments. There are three major reasons that I think behavior genetic studies of families are useful.

The first, and weakest one for social policy, is terribly important to many people in this room. That is, we need to gain a fuller understanding of the nature of human behavior. The naive environmentalism of the past three decades locked us into assumptions that are simply untenable, useless, and wrong-headed. The average layman had better intuitions about the nature of human differences than many psychologists purported to have. I have the sneaky suspicion, however, that most psychologists privately explained behavioral differences much as the rest of the population does. But why should we continue to be publicly wrong?

The second reason for behavior genetic studies of families is more "relevant", to use a phrase of the '60's. These studies can and do provide diagnostic clues about the nature of some developmental problems. Just as a good family history in medicine and clinical psychology expresses a concern for individual risks, so tracing family patterns of behaviors affords us a look at human behavior in the making, and often a more optimistic prognosis. So, father was a "hyperactive boy"; today he is a successful business man. So, when mother was a child, she had a difficult time meeting new people; today she is a respected member of community groups. Psychologists can afford to have more respect for the individual patterns of development that make us different from one another. Biological diversity is a fact of life; respect for individual differences comes very much from that biological perspective, and is not a trivial victory.

Third, and most important to me, are the implications for intervention programs. In its baldest form, I think that naive environmentalism has led us into an "intervention fallacy". By assuming that all of the variance in behavior was environmentally determined, we have blithly promised a world of change that we have not delivered, at great cost to the participants, the public, and ourselves. The fallacy runs like this: if people who do X without our intervention have more desirable outcomes than people who do not do X, then we should persuade, or compel, all people to do X. This is simply not wise, because some of the reasons for the naturally-occuring differences between those who do and do not do X are not just environmental differences. I argue that many of these seemingly environmental variations are actually genetic-differences or gene-environment correlations. People who are different do things differently.

But here is the most costly part of the intervention fallacy: the erroneous belief that small variations in environments within the "humane range" have meaningly different outcomes for children. If we observe that professional families take their children to the theatre more often than working class families, or hang mobiles above their cribs more frequently, some psychologists' feel justified in recommending to everyone that they take in plays frequently, rather than playing baseball in the back yard, or hang mobiles over the crib, rather than carrying the baby about wherever the parents go. Since these are the child-rearing practices of the professional class, whose children excell at IQ tests and in school, some psychologists would advise all parents to alter their child rearing practices to follow suit. It has not been demonstrated that these variations in child rearing are functionally different in their effects on the children, and I will argue that most "humane environments" are in fact functionally equivalent. But the load of guilt and the financial burden placed on parents has been extraordinary, based on studies of the naturally occuring variation among families and the outcome of their biological offspring. Behavior genetic studies of families can spare us all a homogeneity of environmental practices, imposed by an "omniscient" professional class.

I believe that we can do a better job of designing and implementing effective intervention programs, if we know what variations in the environment make a difference and which ones do not. We can shift our resources to the improvement of those circumstances that have clear, environmentally-deleterious effects on people. Many of these we know: after all, as Ed Zigler said at SRCD this spring, we do not have to do research to know that hunger is not good for children, or that child abuse leaves scars. Most of the worst envi-

ronments are obviously deleterious. But there are many other marginal and less obvious practices and conditions that we can only judge from sophisticated research on the effects of those environments. So, it is important to know what aspects of the environment have consequences for behavioral differences, and which ones are only apparent variations, based on cultural preferences, genetic differences or on gene-environment correlations. People deserve respect for self-expression and their own modes of child rearing, unless there is clear environmental reason to intervene. Behavior genetic methods will help us to gain a far clearer understanding of which environmental variables to worry about.

But, let us recall the wisdom of the past: as Thorndike and others said, the average level of our environment is the most important determinant of the level of behavioral development. Therefore, by providing better schooling, nutrition, health care, psychological services and the like, we can raise the average level of the environment and of behavioral development in the whole population.

Scientific evidence on individual and group differences does not speak to the issue of average levels, nor does such research have any implications for the distribution of social justice and economic benefits. These are rights that belong to us as citizens.

But some of you will argue that there are real dangers for social policy from research on individual and group differences.

I personally see no necessary connections between the scientific results I have reported and any social policy. Science is not politics, nor are social policies primarily dependent on scientific evidence, however much we might wish sometimes that they were. Policy matters depend mostly on values, and in

this society, many groups compete over the translation of their values into policies.

Frankly, I think such pluralism is healthy, because we as scientists have no special wisdom in policy matters. Our unique gift to the society is the most objective look we can manage at the nature of the human condition. Hopefully, that information will be noticed and used to improve human lives. As citizens, we can try to be heard, so that our work will have the effects we personally value, but in doing so we must be very careful not to throw away our unique contribution — a set of methods and standards of truthfulness that distinguish us from many other groups.

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FOOTNOTES

A Master Lecture, delivered at the annual meeting of the American Psychological Association, San Francisco, August 26, 1977.

SLIDES

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2	(TRA)	WAIS IQ Scores of Adoptive Parents
3	(TRA)	IQ Scores of the Natural Children of the Adoptive Parents
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21	(PTS)	Lack of Correlation of Racial Ancestry and Intellectual Skills
22	(PTS)	Scatter Plot of Racial Ancestry and General Intellectual Skills
23	(PTS)	Path Model of Ancestry and Intellectual Skills
24	(PTS)	Mean Differences in intellectual performance by race and SES
25	(PTS)	Twin Correlations and "heritabilities"

TRA = Scarr, S. & Weinberg, R.A. IQ Test Performance of Black children adopted by white families. American Psychologist, 1976, 31, 726-739. (Transracial Adoption).

AA = Scarr, S. & Weinberg, R.A. The influence of "family background on intellectual attainment: The unique contribution of adoptive studies to estimating environmental effects. Paper presented at the Mathematical Social Science Board conference on Family Environment and Subsequent Child Development. Stanford, March 24, 1977 (Adolescent Adoption).

PTS = Scarr, S. & Barber, W.B. Philadelphia Twin Study, in preparation.

Slide 1

TABLE 4

Educational Levels of the Natural Parents of Adopted Children, Compared to Their Populations

	Natural parents of the adopted children	Natural parents of the early-adopted children	North Central region	Minneapolis-St. Paul*
Black mothers	10.8	10.8	11.9	12.0
White mothers of interracial children	12.4	12.6	12.5	12.5
Black fathers	12.3	12.6	12.0	12.0

Note. Levels given in years.
* Men or women, aged 25–44 years.

Slide 2

TABLE 6

WAIS IQ Scores of Adoptive Parents

	Mother				Father			
WAIS	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range
Verbal	100	118.3	10.4	92–144	99	120.7	10.6	92–140
Performance	99	115.9	11.3	86–143	99	118.2	10.9	91–149
Full Scale	99	118.2	10.1	96–143	99	120.8	10.0	95–140

Slide 3

TABLE 7

IQ Scores of the Natural Children of the Adoptive Parents

	Total				Males				Females			
Scale	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range
Stanford-Binet	48	113.8	16.7	81–148	26	111.6	16.5	81–148	22	116.3	16.9	88–140
WISC												
Verbal	82	113.5	13.1	84–147	50	114.0	12.8	89–147	32	112.8	13.6	84–144
Performance	82	119.5	14.9	68–147	50	120.5	12.5	82–143	32	117.8	18.1	68–147
Full Scale	82	117.9	12.7	87–150	50	118.5	10.8	96–145	32	117.0	15.3	87–150
WAIS												
Verbal	14	117.5	11.0	100–139	5	121.6	13.9	105–139	9	115.2	9.2	100–125
Performance	14	117.7	10.8	103–137	5	121.8	14.6	104–137	9	115.4	8.1	103–125
Full Scale	14	118.9	11.2	101–141	5	123.0	14.9	104–141	9	116.6	8.6	101–126

Note. WISC = Wechsler Intelligence Scale for Children. WAIS = Wechsler Adult Intelligence Scale.

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TABLE 8

IQ Scores of Adopted Children

	Total				Males				Females			
Scale	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range	*n*	*M*	*SD*	Range
Stanford-Binet	122	106.3	13.9	68–144	69	107.1	12.6	80–144	53	105.6	15.5	68–136
WISC												
Verbal	48	101.2	15.6	66–142	30	101.9	14.4	71–139	18	100.2	17.9	66–142
Performance	48	109.7	17.7	62–143	30	111.0	18.3	62–143	18	107.5	17.0	80–142
Full Scale	48	105.8	16.1	64–140	30	106.9	15.8	64–140	18	104.1	16.8	80–133
WAIS												
Verbal	6	98.3	7.0	86–107	3	95.3	8.7	86–107	3	101.3	2.1	99–103
Performance	6	113.5	6.5	107–119	3	113.0	4.9	107–119	3	114.0	9.5	108–125
Full Scale	6	105.2	6.3	94–113	3	102.7	7.8	94–113	3	107.7	2.9	106–111

Note. WISC = Wechsler Intelligence Scale for Children. WAIS = Wechsler Adult Intelligence Scale.

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TABLE 11

School Achievement Test Scores of Black/Interracial Adopted and Natural Children: Mean National Percentiles

Test	M %ile	SD	n
Black adoptees			
Vocabulary	57.2	29.1	20
Reading	55.0	28.6	24
Mathematics	55.2	29.9	19
Aptitude (IQ)	108.8	5.9	5
Natural children			
Vocabulary	73.1	11.7	48
Reading	74.5	25.8	77
Mathematics	71.3	22.6	69
Aptitude (IQ)	119.6	11.7	39

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Adolescent Sample

Means and SD's for Family Demographic Characteristics and Natural Mother's Characteristics

	Adoptive		Biological	
	Mean	SD	Mean	SD
Fa Educ.	14.9	3.03	15.6	2.83
Mo Educ	14.0	2.06	14.7	2.24
Fa Occup*	60.3	24.14	62.5	24.7
Family Income	25.935.	10,196.	24,987.	8,770.
# Children	2.9	1.20	3.9	1.48
Nat. Mo Age	22.5	5.80		
Educ.	12.0	1.66		
Occup.*	30.4	23.24		

* NORC Scale

Means & SD's for WAIS IQ

	M	SD	N	Range
Bio Pa	117.6	11.9	120	91-144
Ma	113.1	10.5	121	87-140
Son	115.2	10.5	116	94-135
Da	110.0	10.0	145	84-132
Adopt Pa	116.5	10.9	106	92-142
Ma	112.9	10.2	111	91-138
Son	107.8	9.0	88	79-134
Da	105.3	9.3	103	75-128

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Table 4: Standardized Regression Coefficients of Adolescent IQ on Family Demographic Characteristics and Parental IQ in Biologically Related and Adoptive Families

	Bio.	Adopt.	Bio.	Adopt.	Bio.	Adopt.	Adopt.	Adopt.
Family Characteristics / N	237	150	237	150	237	150	150	132
Father's Education	.233	*	.217	*	.072	-.052	-.084	-.025
Mother's Education	.119	.083	.101	.079	-.113	.087	.077	.066
Father's Occupation	-.155	.108	-.166	.102	-.140	.085	.094	.037
Family Income	.145	-.027	.139	.015	.089	-.019	-.104	-.099
Birth Rank			-.162	-.195	-.166	-.196	-.218	-.253
Number of Children			-.103	-.041	-.107	-.052	-.071	-.079
Father's IQ					.308	.158	.146	.116
Mother's IQ					.361	-.023	*	-.024
Natural Mother's Education							.246	.293
Natural Mother's Age							-.147	-.074
Natural Mother's Occupation								.023
R^2	.107	.019	.145	.059	.309	.075	.138	.157

*F < .01

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Table A2: Regression of Child IQ on Adoptive and Natural Midparent Education (N = 21 Families)

	B	beta	F	p	R^2	r
Natural MP Ed	4.028	.499	5.67	.03	.263	.514
Adoptive MP Ed	.304	.055	.07	.79	.267	.188

Variable	Mean	Standard Dev
IQ	108.76	12.14
AMPED	15.98	2.21
NPED*	12.52	1.50

*Students deleted

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Table A3: Regression of Child IQ on Adoptive Midparent and Natural Mother's Education (N = 74 families)

	B	beta	F	p	R^2	r
Natural Mother's Ed	1.58	.237	4.31	.04	.085	.291
Adoptive Midparent Ed	1.31	.224	3.85	.05	.132	.281

Variable	Mean	Standard Dev
IQ	110.22	12.07
AMPED	16.47	2.06
NMED*	12.45	1.81

*Students deleted

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Table 7: Regressions of Child IQ on Family Demographic Characteristics, and Parental IQ in Transracial Adoptive Families with Their Own Children

	Biological Children (143)		Early Adopted Children (111)	
	B	beta	B	beta
Mother's IQ	.474	.32	.141	.13
Father's IQ	.513	.40	-.028	-.02
Father's Ed.	.682	.14	.389	.09
Mother's Ed.	-.943	-.15	1.501	.25
Father's Occ.	-.174	-.23	.008	*
Family Income	.445	.06	-.371	-.06
Total R^2	.301		.156	

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Parent-Child IQ Correlations

(Transracial Adoptive Familes with Their Own Children)

	Natural Children*	Adopted Children**
Adoptive Mother IQ	.49 (N = 141)	.20 (N = 109)
Adoptive Father IQ	.54 (N = 142)	.01 (N = 111)
Midparent IQ	.66 (N = 140)	.30 (N = 109)

* Corrected for restriction of range in parents' IQ scores

** Corrected for restriction of range and selective placement

TABLE 6
Intraclass Correlations of IQ Scores for Sibling Pairs by Family Constellation

	Natural/natural				Adopted/natural					Adopted/adopted								
	N	r_i	MS_w	MS_B	*N*	r_i	MS_w	MS_B	$(\hat{r}_i)^a$	*N*	r_i	MS_w	MS_B	$(\hat{r}_i)^a$	h^2 NN/AN	$(\hat{h}^2)^a$ NN/AN	h^2 NN/AA	$(\hat{h}^2)^a$ NN/AA
Sibling pairs in families with natural *and/or* early adopted children																		
All IQ scores	107	.42	.58	1.4	134	.30	.70	1.3	(.37)	53	.39	.62	1.4	(.47)	.25	(.10)	.06	(.00)
Sibling pairs in families with *both* natural *and* early adopted children																		
All IQ scores	75	.37	.63	1.4	134	.30	.70	1.3	(.37)	21	.49	.53	1.5	(.58)	.15	(.00)	.00	(.00)

[a] Corrected for restricted range in adopted children's IQ scores

Table 8 Slide 13

Correlations Among Family Members in Adoptive and Biologically-Related Families (Pearson Coefficients on Standardized Scores by Family Member and Family Type) for Intelligence Test Scales

	Reliability	Biological				Adoptive			
Child Score	(*)	MO	FA	CH	MP	MO	FA	CH	MP
Total WAIS IQ	(.97)	.41	.40	.35	.52	.09	.16	-.03	.14
Subtests									
Arithmetic	(.79)	.24	.30	.24	.36	-.03	.07	-.03	-.01
Vocabulary	(.94)	.33	.39	.22	.43	.23	.24	.11	.26
Block Design	(.86)	.29	.32	.25	.40	.13	.02	.09	.14
Picture Arrangement	(.66)	.19	.06	.16	.11	-.01	-.04	.04	-.03

__ = biological > adoptive correlation, $p < .05$.

MO = mother-child; FA = father-child; CH = child-child; MP = midparent-child.

Sample Sizes

	Biological				Adoptive			
	MO	FA	CH	MP	MO	FA	CH	MP
Child Tests	270	270	168	268	184	175	84	168

Assortative Mating

	Biological	Adoptive
	FA-MO	FA-MO
WAIS IQ	.2[illegible]	.31
Arithmetic	.19	-.04
Vocabulary	.32	.42
Block Design	.19	.15
Picture Arrangement	.12	.22
Sample Size	120	103

*alpha reliability reported in the WAIS manual for late adolescents.

Table 9

Differences Between the Correlations of Genetically-Related and Unrelated Family Members and "Heritabilities"

	Related-Unrelated				$1.6(r_{np-c} - r_{ap-c})$		
Child Score	MO	FA	CH	MP	MO	FA	CH
Total WAIS IQ	.31	.24	.38	.38	.50	.38	.61
Subtests							
Arithmetic	.27	.23	.27	.37	.43	.37	.43
Vocabulary	.10	.15	.11	.17	.16	.24	.18
Block Design	.16	.30	.16	.26	.26	.48	.26
Picture Arrangement	.20	.10	.12	.14	.32	.16	.19

MO = mother-child

FA = father-child

CH = child-child

MP = midparent-child

Preliminary Data From The Texas Adoption Project

Adults-Beta vs Child-WAIS/WISC/Binet

	r	n
Ad. Mother-child-nat	.20	(163)
" " " ad	.19	(458)
Ad. Father-child-nat	.25	(164)
" " " ad	.12	(461)
Bio-mother-her child	.29	(345)
Ad. Father-ad mother	.24	(292)
Ad. Mother-bio mother	.15	(303)
Ad. Father-bio mother	.12	(305)
Natural sibs	.37	(86)
Adopted sibs	.22	(317)
Adopted-natural pairs	.30	(317)

Ns are the number of different children involved in the parent-child and sibling correlations, and the number of biological mothers in the biomother-parent correlations. Thus Ns are somewhat inflated, in the sense that a given parent may be entered more than once. Siblings are intraclass. Total no of families = 300, 120 with one or more natural children.

TABLE I

Type of Dyslexia in 1st Degree Relatives

Type of Dyslexia in Proband	N	Verbal	Auditory	Mixed	Uncharacterized	Total
Verbal	11	17	1	1	5	24
Auditory	7	1	10	0	7	18
Mixed	3	2	3	5	2	12

Table 2 Regression of mid-child on mid-parent (± s.e.) for cognitive tests and factor scores in two ethnic groups

	Uncorrected		Corrected†	
	AEA	AJA	AEA	AJA
Tests				
Vocabulary	0.65±0.05	0.57±0.07	0.68±0.04	0.59±0.07
Visual memory (immediate)	0.15±0.05	0.16±0.08	0.26±0.05	0.28±0.08
Things	0.41±0.05	0.27±0.09	0.55±0.04	0.36±0.09
Mental rotations	0.42±0.05	0.37±0.09	0.48±0.05	0.42±0.09
Subtraction and multiplication	0.38±0.04	0.29±0.09	0.40±0.04	0.30±0.09
"Lines and dots" (Elithorn mazes)	0.22±0.05	0.19±0.08	0.25±0.05	0.21±0.08
Word beginnings and endings	0.40±0.04	0.39±0.09	0.56±0.04	0.55±0.08
Card rotations*	0.46±0.05	0.25±0.08	0.53±0.04	0.28±0.07
Visual memory (delayed)	0.33±0.05	0.22±0.09	0.53±0.04	0.35±0.09
Pedigrees	0.53±0.04	0.46±0.08	0.74±0.04	0.64±0.07
Hidden patterns	0.43±0.05	0.27±0.08	0.47±0.05	0.29±0.08
Paper form board	0.53±0.04	0.48±0.09	0.63±0.04	0.57±0.09
Number comparisons	0.39±0.05	0.32±0.08	0.48±0.04	0.40±0.08
Social perception	0.27±0.05	0.24±0.07	0.39±0.05	0.35±0.07
Progressive matrices*	0.51±0.04	0.27±0.07	0.59±0.04	0.31±0.07
Factors				
Verbal	0.57±0.04	0.51±0.07	0.65±0.04	0.58±0.07
Spatial	0.57±0.05	0.41±0.08	0.61±0.04	0.44±0.08
Perceptual speed	0.41±0.05	0.29±0.09	0.46±0.04	0.32±0.09
Visual memory	0.32±0.05	0.22±0.09	0.44±0.05	0.31±0.09
First principal component*	0.61±0.04	0.42±0.07	0.63±0.04	0.43±0.06
No. of families‡	739	244	739	244

*Significant difference between AEA and AJA regression coefficients ($P < 0.05$).

†Corrected for test reliability.

‡AEA data from 482 one-child families, 224 two-child families, 30 three-child families and 3 four-child families. AJA data from 198 one-child families, 36 two-child families, 9 three-child families and 1 four-child family.

Profile Contour Correlations for Holland Interest Styles

	Biological	Adopted	t between correlations
Father-Mother	.11	.11	n.s.
Father-Son	.29**	.13	2.56**
Mother-Daughter	.24**	.13	1.84*
Father-Daughter	.19*	.06	2.12*
Mother-Son	.24**	.07	2.58**
Brother-Brother	.33*	—	—
Sister-Sister	.34**	—	—
Child-Child	.25***	.08	2.92**

Note. t-test based on the following formula (Dworkin, Note 2; Wilson, 1972):

$$t = \frac{z_1 - z_2}{\sqrt{\frac{1}{(tests - 1)\ (prs_1 - 2)} + \frac{1}{(tests - 1)\ (prs_2 - 2)}}}$$

*p < .05

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F-Scale: Family Correlations Based on Scores Standardized by Sex, Generation and Family Type

	Correlations			
	r_{bio}	r_{adopt}	$r_{bio}-r_{adopt}$	t_{corr}
Fa-Mo	.43	.34	.09	0.78
Fa-Child	.37	.14	.23	2.44**
Fa-Da	.34	.31	.03	0.24
Fa-Son	.44	-.05	.49	3.62***
Mo-Child	.41	.00	.41	3.45***
Mo-Da	.40	.06	.34	2.79**
Mo-Son	.41	-.06	.46	3.45***
MP-Child	.44	.06	.38	4.33***
MP-Da	.43	.20	.23	1.91*
MP-Son	.51	-.08	.59	4.35***
Child-Child	.36	.14	.22	1.71*
Son-Son	.46	--		--
Da-Da	.36	--		--
Son-Da	.41	.04	.37	2.26*

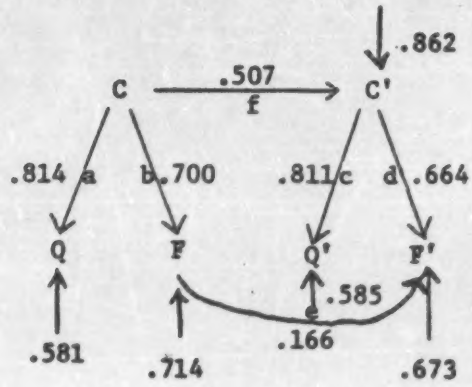
*$p < .05$, one-tailed

**$p < .01$, one-tailed

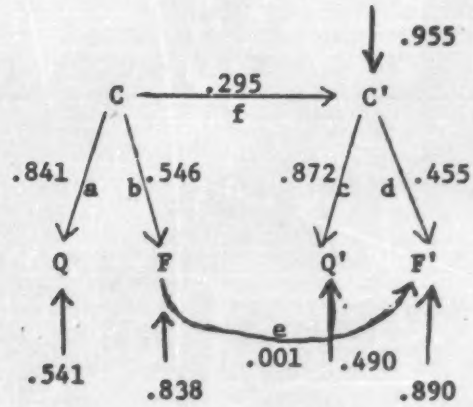
***$p < .001$, one-tailed

Average Model 3 Fits -- Standardized Coefficient

Biological P-C



Adoptive P-C



(Bio) - (Adopt)

1) Individuals

$P_{CQ} = -.029$ $P_{C'Q'} = -.061$

$P_{CF} = .154$ $P_{C'F'} = .209$

2) Pairs

$P_{CC'} = .212$

$P_{FF'} = .165$

Table 7. Correlations of ancestral and sample odds coefficients with intellectual skills

	Ancestral odds	Sample odds
Raven standard progressive matrices	−0.08	−0.13
Peabod picture vocabulary test	−0.06	0.00
Columbia test of mental maturity	0.02	−0.04
Revised test of figural memory	−0.12	−0.10
Paired-associate test	0.15	0.12
First principal component	−0.03	−0.05

$n = 144$ pairs; $r \leq -0.14$, one-tailed test, $P \leq 0.05$; SE = 0.083

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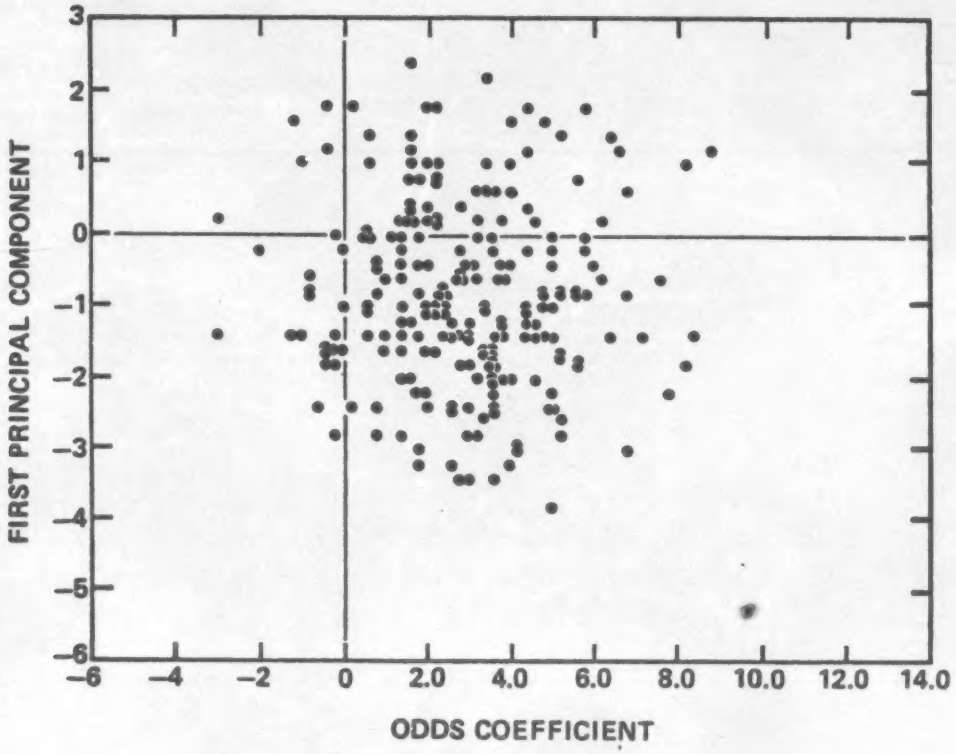
FIRST PRINCIPAL COMPONENT
3
2
1
0
−1
−2
−3
−4
−5
−6
−6
−4
−2
0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
ODDS COEFFICIENT

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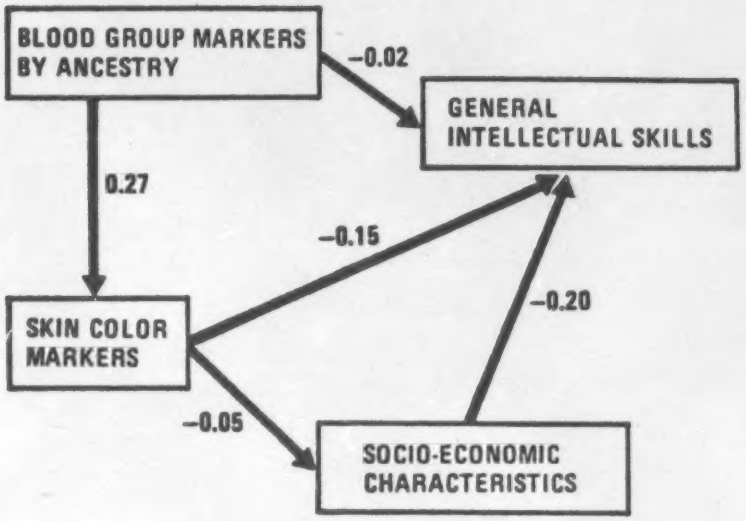
BLOOD GROUP MARKERS BY ANCESTRY
-0.02
GENERAL INTELLECTUAL SKILLS
0.27
-0.15
-0.20
SKIN COLOR MARKERS
-0.05
SOCIO-ECONOMIC CHARACTERISTICS

Table 10

Mean Differences in Performance on Five Cognitive Tests by Race and SES* (mean = 0, SD = 1)

	White-Black	White Hi-Lo	Black Hi-Lo
Ravens Matrices	.82	.37	.27
Columbia Mental Maturity	.61	.24	.05
Peabody Picture Vocab. Test	1.05	.38	.29
Figural Memory	.65	.39	.04
Paired-Associate	.41	.33	.07

N = 440 white, 350 Black (invalid tests eliminated)

* SES measured by median census tract educational levels and income

Table 17

Comparisons of MZ and DZ Correlations and Heritabilities for Normalized Standard Scores on Five Cognitive Measures by Race

Black

Test	MZ (65)	DZ (95)	t	MZ-DZ
Raven	.63	.36	2.07*	.27
Columbia	.46	.25	1.51	.21
Peabody	.66	.52	1.37	.14
Benton E	.61	.31	2.49**	.30
P-A	.65	.40	1.66*	.25

White

Test	MZ (121)	DZ (91)	t	MZ-DZ
Raven	.59	.15	3.65***	.44
Columbia	.39	.11	2.25*	.28
Peabody	.64	.40	2.44**	.24
Benton E	.57	.22	3.05**	.35
P-A	.56	.49	.64	.07